

2.0 RED LIGHT RUNNING AND ACCIDENTS

According to the Fatality Analysis Reporting System (FARS) and the General Estimate System (GES) for the year 1997, approximately 800,000 motor vehicle collisions occurred at signalized intersections for the year 1997. The estimated result was over one half million injuries and several thousand fatalities. Collisions at intersections are reported to be increasing. At least one study has shown that motorists involved in red light running collisions are more likely to be injured than in other types of collisions - 45 percent of the collisions resulting from red light running caused injuries, compared to 30 percent for all other collision types.

Comprehensive traffic safety improvement programs are normally built around the three E's of Enforcement, Engineering, and Education and all can be expected to play a role in improving traffic safety. Red light running is clearly one example of risky driving behavior that impacts traffic safety and should be modified but how can this best be achieved? How can intersection safety best be improved? The use of photo enforcement systems is an approach that, with an increasing number of system deployments throughout California and other States, has proven to be effective in reducing the number of red light running violations that can lead to collisions and, more directly, in reducing the number of accidents caused by red light running.

Two of the most direct measures that are commonly applied to evaluate the effectiveness of photo enforcement programs and may be applied for the City's Photo Enforcement Program are the following:

- Reductions in the number of accidents after the installation and operation of photo enforcement cameras; and
- Reductions in the number of red light running violations after the installation and operation of photo enforcement cameras.

2.1 RED LIGHT RUNNING VIOLATIONS BEFORE AND AFTER ENFORCEMENT

In addressing the important question of safety improvements and the effectiveness of the City's Photo Enforcement Program, it is necessary to establish whether the implementation of the program has indeed reduced red light running. Unfortunately, there is no photographic or other evidence that reflects the true "before" situation. For analysis purposes, the level of violations recorded for the first three months of the program at each location has been considered as the "before" condition. This assumption that the initial three-month period accurately reflects the "before" situation is a reasonable one as completed studies where actual "before" data has been available have indicated that approximately three months is typically required before the hoped-for driver behavior modifications are observed and reductions in the number of violations are recorded. However, there are difficulties with the first month of data since the program was started on different days of the month at each of the photo-enforced locations. To adjust for this data analysis problem, the first month of violations data reported for each location was dropped and the only violations data for the second and third months, the first two full months of operation, has been used.

San Diego Photo Enforcement System Review

The comparison of before and after violations data is based on the monthly violations data reported for each photo-enforced intersection by LM/ACS. The number of violations reported for each location by LM/ACS is determined from the photographic record of drivers triggering the cameras according to the agreed-upon parameters for the operation of the cameras.

Intersections were made operational one at a time over a period of nearly three years. The length of the period of operation varies from as long as 34 months to as little as 12 months. Due to these different data collection periods, the intersections have been classified into three groups so that the comparisons can be made for equal periods of time in operation. Table 2-1 summarizes the number of intersections and intersections identifiers for the three time periods, 12 months, 24 months, and 30 months.

Table 2-1
PHOTO-ENFORCED INTERSECTIONS
GROUPED BY NUMBER OF MONTHS IN OPERATION

Data Collection Period	Number of Intersections	Photo Enforced Intersection Identifiers
12 months	8	1523, 1533, 1534, 1541, 1542, 1543, 1551, 1553
24 months	4	1484, 1492, 1504, 1513
30 months	7	1404, 1414, 1422, 1444, 1454, 1462, 1474

Figure 2-1 summarizes the trends observed in the violations data for each of the three groups of intersections. The average number of “before” violations (as measured for the first two full months of operation) and average number of “after” violations are shown in Figure 2-1.

From Figure 2-1, it may be observed that:

- Photo enforcement results in a significant reduction in the number of red light running violations;
- The measured reduction in red light running violations at intersections where cameras have been operational for six months varies from 20 percent to nearly 24 percent; and
- The measured reductions in red light running violations remain constant as the cameras are operated for longer periods of time.

Using violations data for months after nine months of photo enforcement operations, there is a slightly greater reduction in the number of violations but the difference is marginal when compared with those after six months.

Figure 2-1 also illustrates that the decreasing patterns of the violation numbers are consistent over the three different intersection groups that indicates that the drivers' behavior has been influenced in a similarly consistent manner over the different intersections. The measured changes in the average number of violations at each photo-enforced intersection are attached as Appendix C.

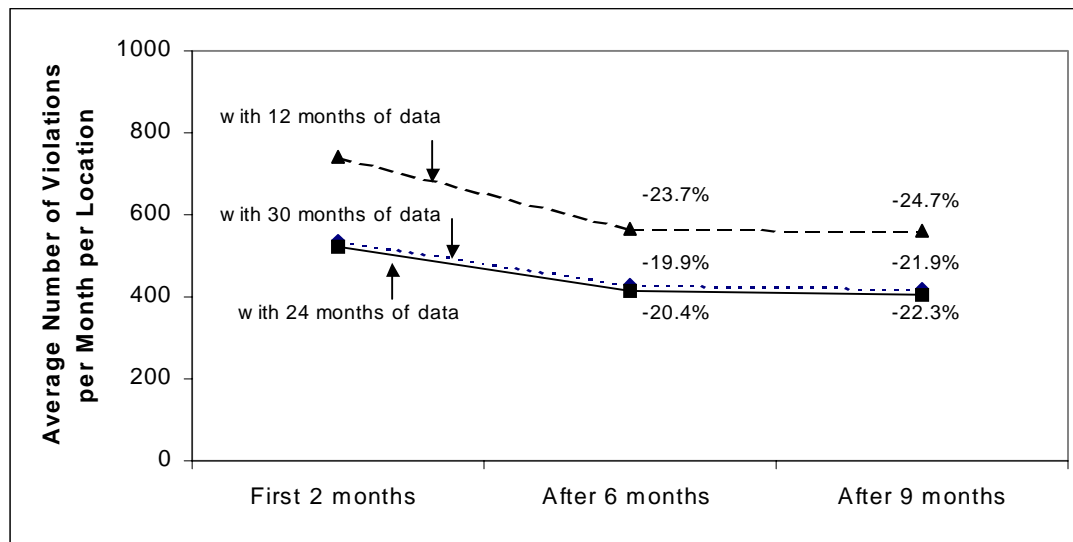


Figure 2-1
OBSERVED REDUCTIONS IN RED LIGHT RUNNING VIOLATIONS

Figure 2-2 provides a different view of the same violations data trends, showing the average number of violations per month for the following four groups of intersections:

Table 2-2
PHOTO-ENFORCED INTERSECTIONS GROUPED BY LEFT TURN VERSUS THROUGH ENFORCEMENT AND NUMBER OF MONTHS IN OPERATION

Data Collection Period	Number of Intersections	Photo Enforced Intersection Identifiers
12 months Left Turns (LT12)	3	1533, 1541, 1543
24 months Left Turns (LT24)	6	1414, 1422, 1462, 1474, 1492, 1513
12 Months Through (TH12)	5	1523, 1534, 1542, 1551, 1553
24 Months Through (TH24)	5	1404, 1444, 1454, 1484, 1504

From Figure 2-2, it is noted that the reductions observed in the number of violations over time are distributed between intersections where left turns and through enforcement is being done. A very large reduction, 54 percent, is noted for the group consisting of five intersections where the through traffic movements are enforced. This rate of reduction is not observed for the other group of intersections where there is through enforcement so that a more general conclusion regarding the larger drop in the number of violations for intersections with through enforcement cannot be made.

Figure 2-2 also illustrates the very high number of violations being generated by the three intersections with left turn enforcement where 12 months of violations data is available. Further examination of the violations data indicates that the very high number of violations for this group is attributable to one location, left turns from North Harbor Drive to Grape Street.

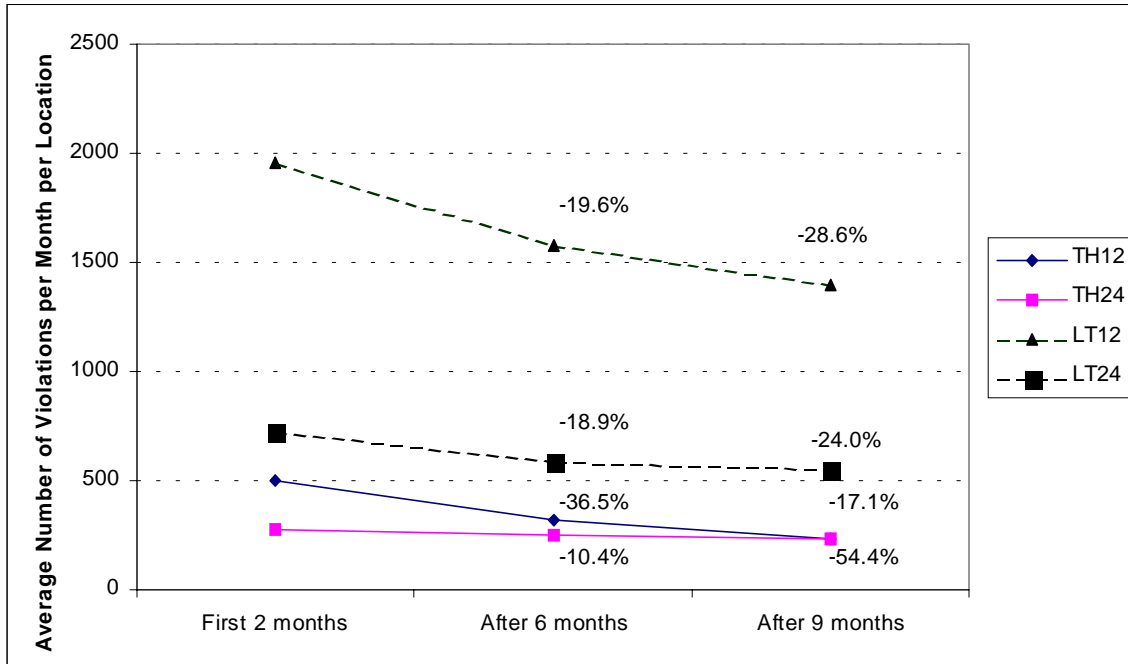


Figure 2-2
AVERAGE NUMBER OF VIOLATIONS PER MONTH
BY LEFT TURN VERSUS THROUGH ENFORCEMENT

2.2 ACCIDENTS BEFORE AND AFTER PHOTO ENFORCEMENT

The overall objective of the City's photo enforcement program is to improve traffic safety at signalized intersections by reducing the number of red light running violations and collisions attributable to red light running. "Before" and "after" accident data was provided by the City's Traffic Engineering Department and has been analyzed. While the accident data analysis indicates that the number of accidents attributable to red light running has been significantly reduced for the photo-enforced intersection approaches, it needs to be noted that reported accidents are statistically rare occurrences that require long monitoring periods in order to generate sample sizes that are sufficiently large to determine changes with complete certainty.

The accident data analysis has not accounted for any Citywide trends or changes in the incidence of accidents attributable to red light running. Additionally, the accident data analysis has not made any adjustments in the accident data for changes in traffic volumes.

For the study, accident records for the all photo-enforced intersections were provided by the City's Traffic Engineering Department. The accident data covered the time period from April 1995 through October 2001. Since the photo enforcement program was initially deployed in July 1998, accident data is available the time periods before and after the startup of the photo enforcement program.

San Diego Photo Enforcement System Review

Two accident types, Right Angle (RA) and Ran Signal (RS), are treated as the principal types of accidents associated with red light running. The effectiveness of the photo enforcement cameras was evaluated by comparing the average numbers of RA/RS accidents before and after photo enforcement. Since the actual enforcement start dates of the photo-enforced intersections are different by location, it was necessary to break out the accident data for each intersection accordingly.

To get a perspective on the overall accident rate change at the 19 photo-enforced intersections, the change of all types of accidents before and after photo enforcement was compared (see Figure 2-3). The annual average accident rate at each intersection increased from 7.6 to 7.8 after photo enforcement. However, the increased accident rate after photo enforcement resulted from the large increase of non-RA/RS accidents, which increased by one-third from 4.7 accidents per year to 5.8 accidents per year on the average (see Section 2.4). At the same time, the average accident rate for RA/RS accidents, accidents that are attributable to red light running, dropped by 30 percent (see Section 2.3).

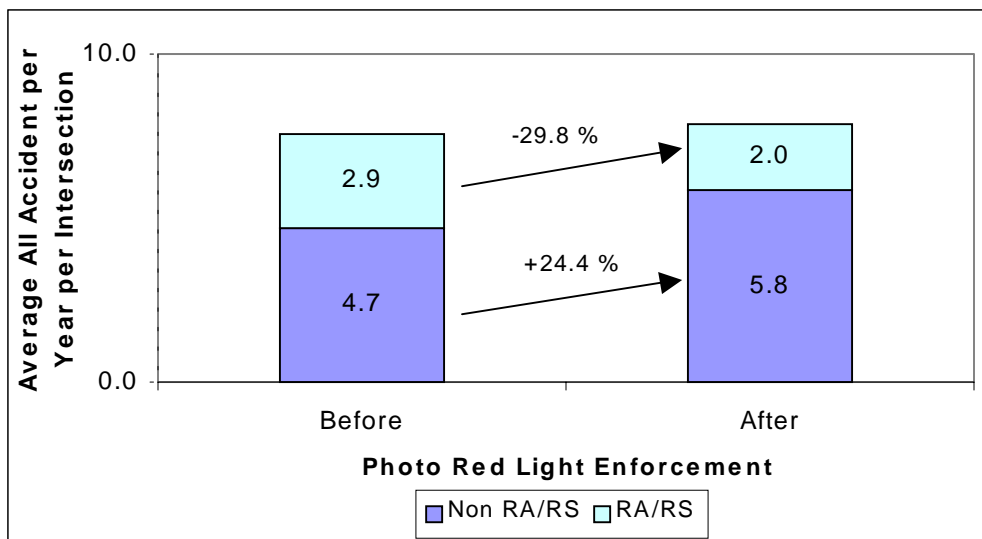


Figure 2-3

CHANGE IN ACCIDENT RATES BEFORE AND AFTER PHOTO ENFORCEMENT BY TYPE OF ACCIDENT

For the photo-enforced intersections, the accident data analysis indicates that the overall accident rate increased by about three percent at the photo enforced intersections but that the accidents related to red light running by motorists dropped by 30 percent after photo enforcement.

2.3 RA/RS ACCIDENTS BEFORE AND AFTER PHOTO ENFORCEMENT

The average accident rate for RA/RS accidents, accidents that are attributable to red light running, dropped by 30 percent for the 19 photo-enforced intersections after the introduction of the photo enforcement cameras.

2.3.1 RA/RS Accident Rate Changes By Movement Type

In order to investigate the RA/RS accident rate changes in greater detail, they were classified into two groups: accidents for photo-enforced traffic movement and for non-enforced movement. Figure 2-4 shows the average RA/RS accident rates for both groups before and after photo enforcement. Before photo enforcement, there was an average of 2.9 accidents per year at the photo-enforced intersections and this rate dropped by about 33 percent to 1.9 accidents per year after photo enforcement. At the same time, the accident rates for the photo-enforced traffic movements dropped by nearly 46 percent while the accident rate for the movements that are not photo-enforced declined by a smaller amount, about 25 percent.

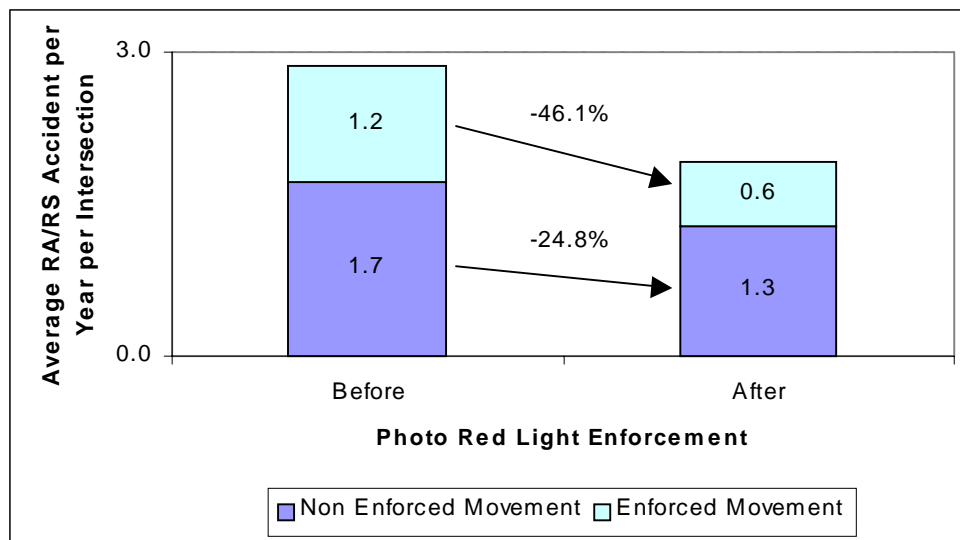


Figure 2-4
RA/RS ACCIDENTS BY MOVEMENT TYPE

2.3.2 RA/RS Accident Rate Changes By Intersection Type

The accident data was analyzed to determine if there were differences in the accident rate changes for photo-enforced intersections where the Through Movement (THM) is enforced in comparison with intersections where Left Turn Movement (LTM) is enforced. Before photo enforcement, the average RA/RS accident rate of the THM intersections was 3.1 accidents per year, which is slightly higher than for LTM intersections where the RA/RS accident rate was 2.6 accidents per year. After photo enforcement, the average RA/RS accident rates dropped by 44 percent for THM intersections and by 20 percent for LTM intersections, respectively, meaning that photo enforcement is about twice as effective in reducing the rate of accidents at intersections where the through traffic movements are enforced.

The accident rate changes for enforced traffic movement and other movements of the THM-type intersections have been compared. As shown in Figure 2-6, the accident rates for both types of traffic movements before photo enforcement was introduced were similar. However, photo enforcement reduced the accident rate of enforced movement by 60 percent while, at the same

San Diego Photo Enforcement System Review

time, there was a reduction of about 30 percent in the accident rate for the non-enforced movements at the photo-enforced intersections.

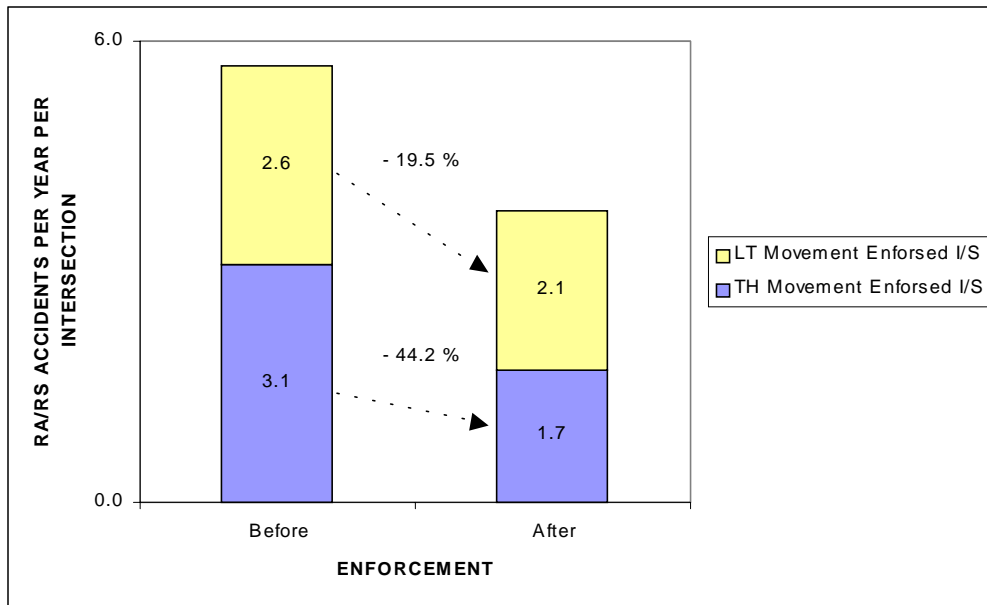


Figure 2-5
ACCIDENT RATES FOR INTERSECTIONS WHERE THROUGH MOVEMENTS ENFORCED AND LEFT TURN MOVEMENTS ENFORCED

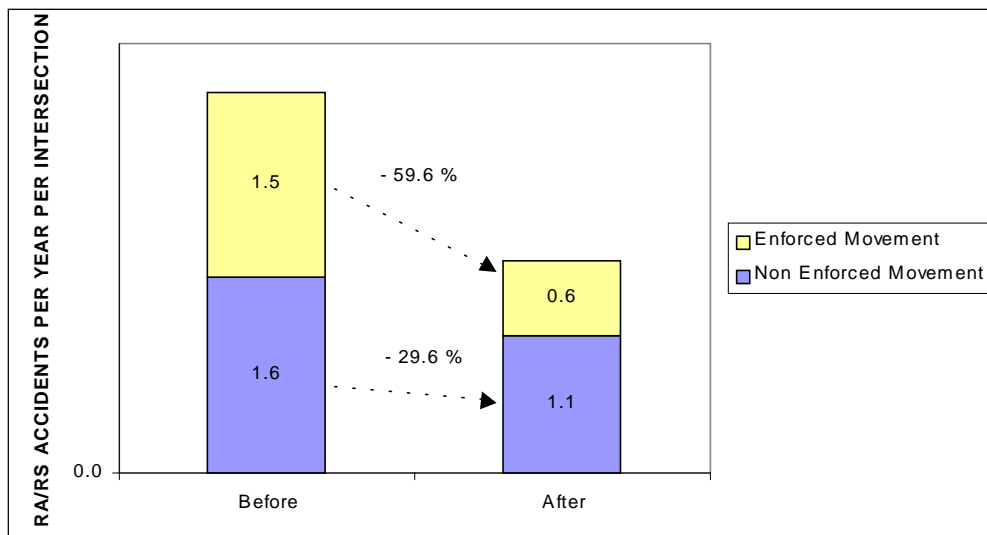


Figure 2-6
ACCIDENT RATES FOR ENFORCED AND NON-ENFORCED MOVEMENTS AT INTERSECTIONS WHERE THROUGH MOVEMENTS ENFORCED

The average accident rate for the enforced movements at LTM intersections before photo enforcement was not high. After photo enforcement, it was found that the average accident rate for the photo-enforced movement was reduced by about 12 percent.

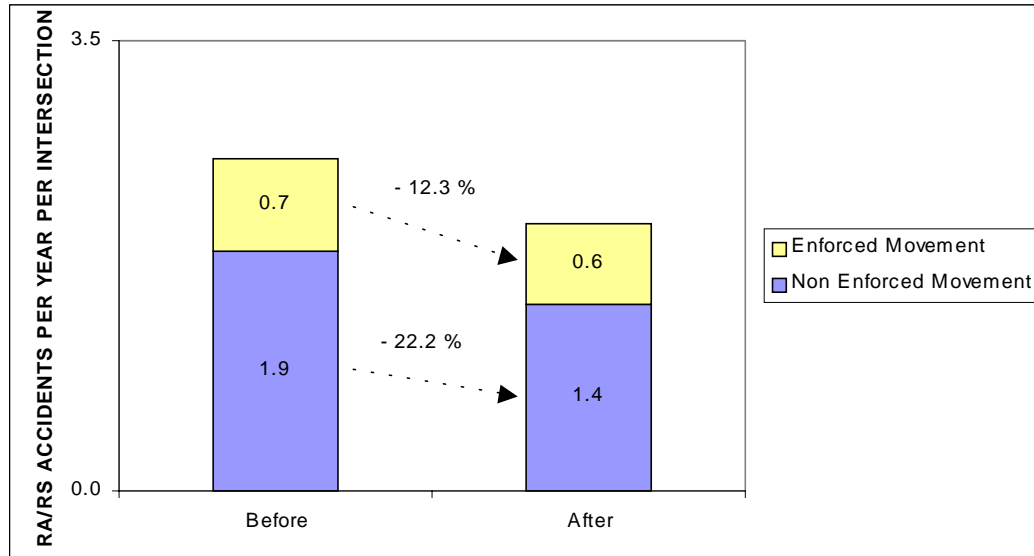


Figure 2-7
ACCIDENT RATES FOR ENFORCED AND NON-ENFORCED MOVEMENTS AT INTERSECTIONS WHERE LEFT TURN MOVEMENTS ENFORCED

2.3.3 Before And After RA/RS Accident Rates By Intersection

Figure 2-8 summarizes the accident rates for each of the photo-enforced intersections before photo enforcement. From this summary, it is noted that the RA/RS accident rate before photo enforcement was remarkably low at the following three intersections:

- NB Bernardo Drive to WB Rancho Bernardo Drive (1414)
- SB Harbor Drive to EB Grape Street (1533)
- SB Mission Boulevard at Garnet Avenue (1542)

One of these locations, at North Harbor Drive and Grape Street has accounted for nearly one-quarter of the recorded violations and citations issued under the City's photo enforcement program.

As the program moves forward, intersections experiencing the highest number of RA/RS accidents should be considered first for photo enforcement. Locations where the accident rates are not high, even locations where there may be high numbers of red light running violations, should not be enforced except to achieve a uniform geographic distribution of the photo-enforced intersections.

Figure 2-9 summarizes the accident rates for each of the photo-enforced intersections after photo enforcement. The RA/RS accident rates for the three intersections noted above remained low after photo enforcement.

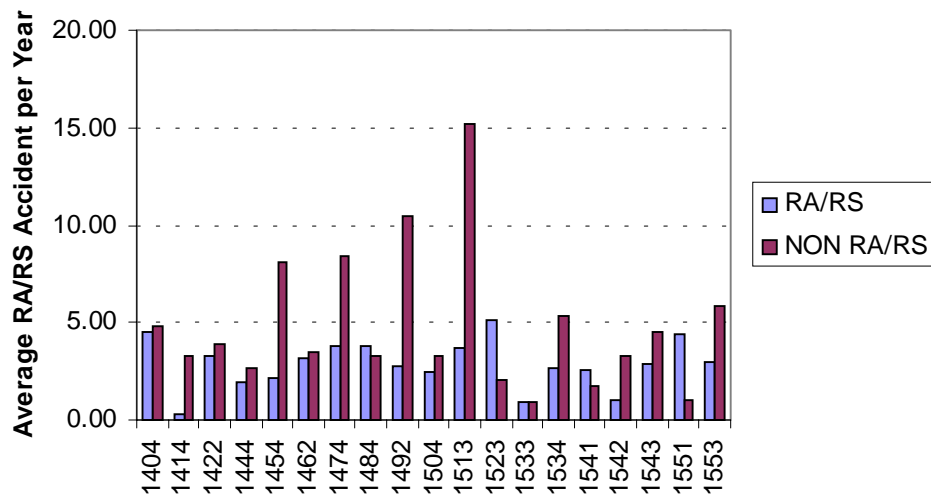


Figure 2-8
BEFORE PHOTO ENFORCEMENT ACCIDENT RATES
AT PHOTO-ENFORCED INTERSECTIONS

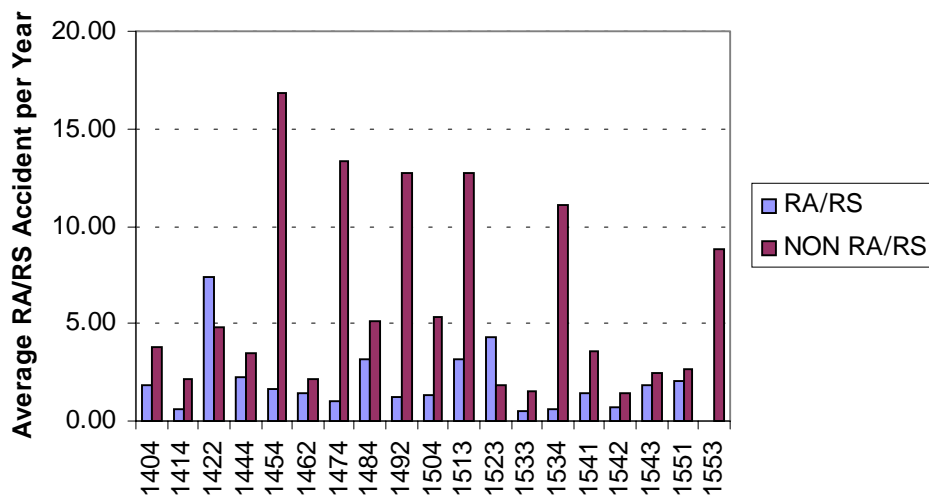


Figure 2-9
AFTER PHOTO ENFORCEMENT ACCIDENT RATES
AT PHOTO-ENFORCED INTERSECTIONS

2.4 NON-RA/RS ACCIDENTS BEFORE AND AFTER PHOTO ENFORCEMENT

The analysis of before and after RA/RS accidents showed that photo enforcement reduced the RA/RS accidents significantly at the photo-enforced intersections. However, it was also noted that the overall accident rate at the photo-enforced intersections increased by about three percent. An analysis of the non-RA/RS accidents by type has shown that the increased accident rate is the result of an increased number of rear end (RE) collisions at the photo-enforced intersections.

This section compares the average RE accident rates before and after photo enforcement. The same data provided by the City Traffic Engineering Department and used for the RA/RS accidents comparison was employed for this analysis.

2.4.1 Overall RE Accident Rate Change

Figure 2-10 illustrates the changes in the overall intersection accident rates broken down by RA/RS accidents, RE accidents, and other types of accidents. According to Figure 2-10, RA/RS accidents decreased by 31 percent or 0.9 accidents per year per intersection on the average while RE accidents increased by 37 percent or 1.2 accidents per year per intersection on the average. Other types of accidents, non-RE/RA/RS accidents, remained virtually unchanged, dropping by about 0.1 accidents per year per intersection. It should be noted that no change in the number or rate of other types of accidents should be expected and none was measured from the before and after data for the photo-enforced intersections.

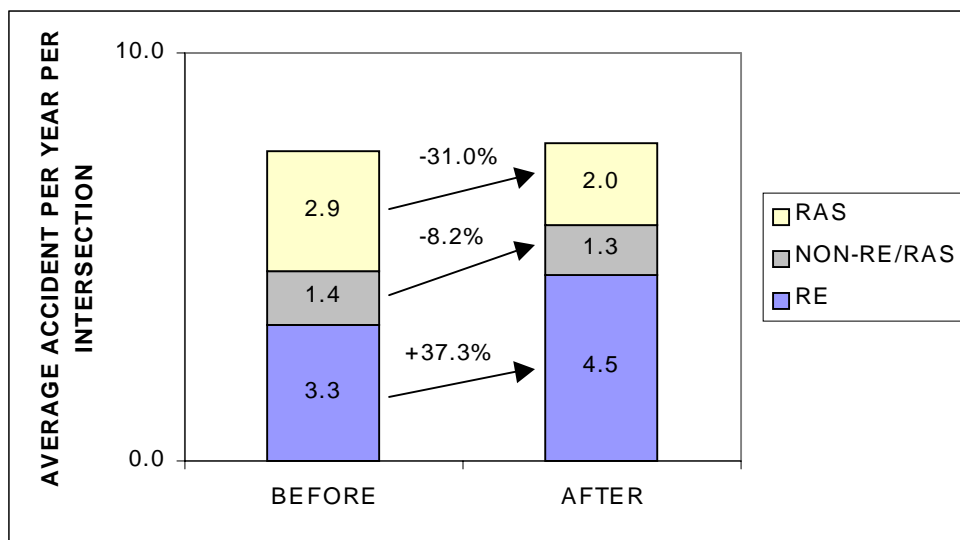


Figure 2-10
AVERAGE ACCIDENT RATE CHANGE BY ACCIDENT TYPES

2.4.2 Average Rear End Accident Rate Change by Traffic Movement

The RE accident rate changes were compared for two groups, RE accidents for the photo-enforced traffic movement and RE accidents for the non-enforced movements. Figure 2-11

shows the average RE accident rates for both groups before and after photo enforcement. Before photo enforcement, there was an average of 3.3 accidents per year at the photo-enforced intersections and this rate increased to 4.5 accidents per year after photo enforcement. The average annual rate of RE accidents for the photo-enforced traffic movements increased by nearly 45 percent and the annual rate of RE accidents for the movements that are not photo-enforced increased by a smaller amount, 31 percent.

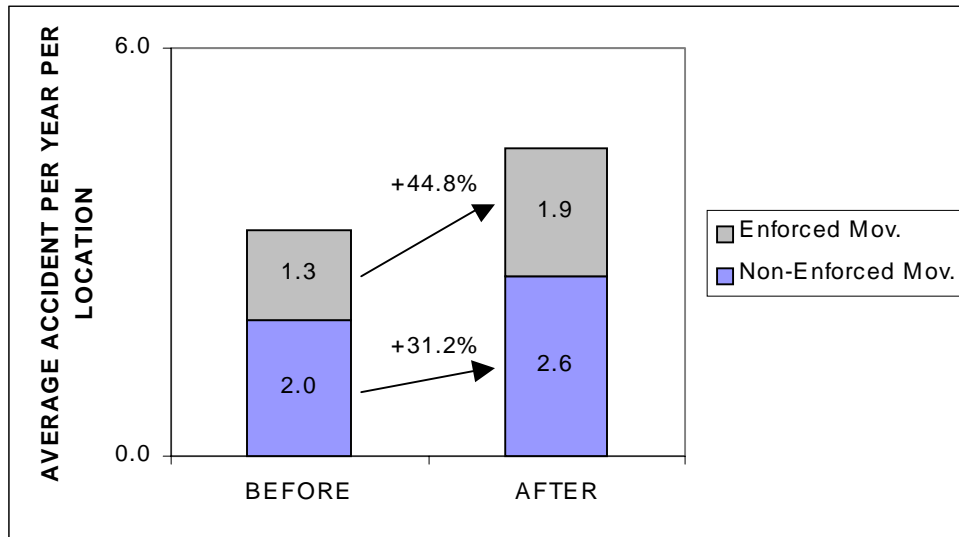


Figure 2-11
AVERAGE REAR END ACCIDENT RATE CHANGE BY TRAFFIC MOVEMENT

2.4.3 Average Rear End Accident Rate Change For Through Movement Enforced Intersections

The RE accident data was analyzed to determine if there were differences in the RE accident rate changes at the Through Movement (THM) enforced intersections.

Before photo enforcement, the average RE accident rate of the THM intersections was 2.6 accidents per year but the rate increased to 3.8 accidents per year after photo enforcement. Figure 2-12 shows that, after photo enforcement, the average RE accident rates increased by 62 percent for the enforced movement and by nearly 43 percent for the non-enforced movements, respectively. Photo enforcement resulted in significantly higher RE accident rates at photo-enforced intersections where a THM was enforced, especially for the enforced THM movement.

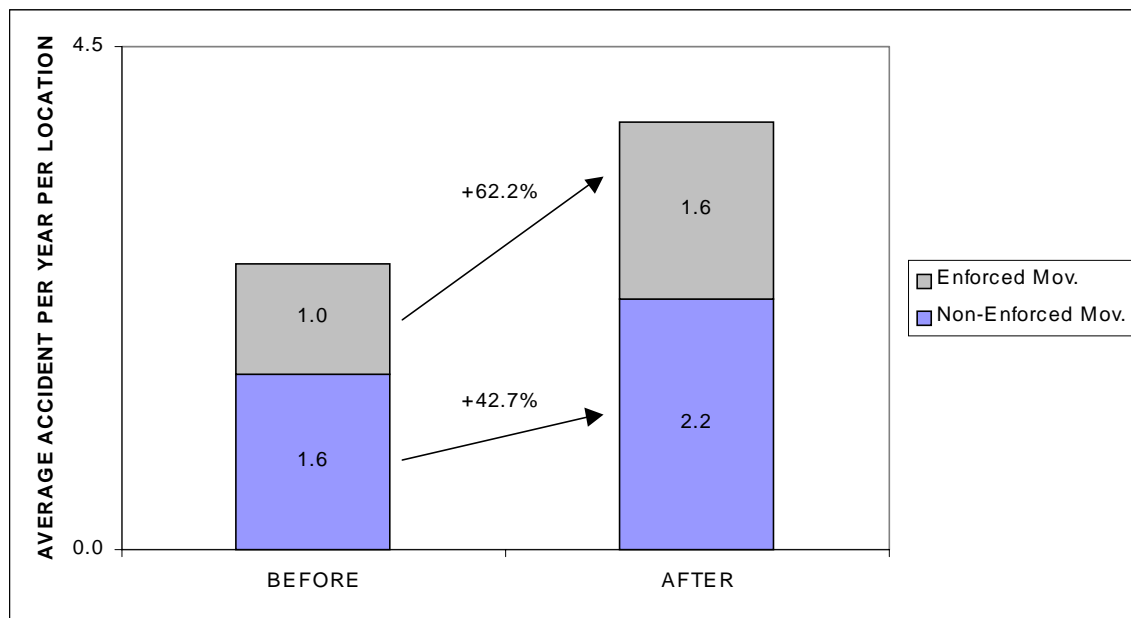


Figure 2-12
REAR END ACCIDENT RATES FOR ENFORCED AND NON-ENFORCED MOVEMENTS AT INTERSECTIONS WHERE THROUGH MOVEMENTS ENFORCED

2.4.4 Average Rear End Accident Rate Change For Left Turn Enforced Intersections

Figure 2-13 shows the RE accident rate changes for Left Turn Enforced (LTM) intersections. Before photo enforcement, the average RE accident rate of the LTM intersections was 4.3 accidents per year. After photo enforcement, the RE accident rate increased to 5.2 accidents per year on the average, by 28 percent for the enforced movement and by about 19 percent for the non-enforced movements, respectively. When compared with those at THM enforced intersections, the RE accident rate changes at LTM intersections are not as large. The slower approach speeds that are typical for left turn lane traffic movements could be a possible explanation for the lower increase in the RE accident rate at LTM enforced intersections.

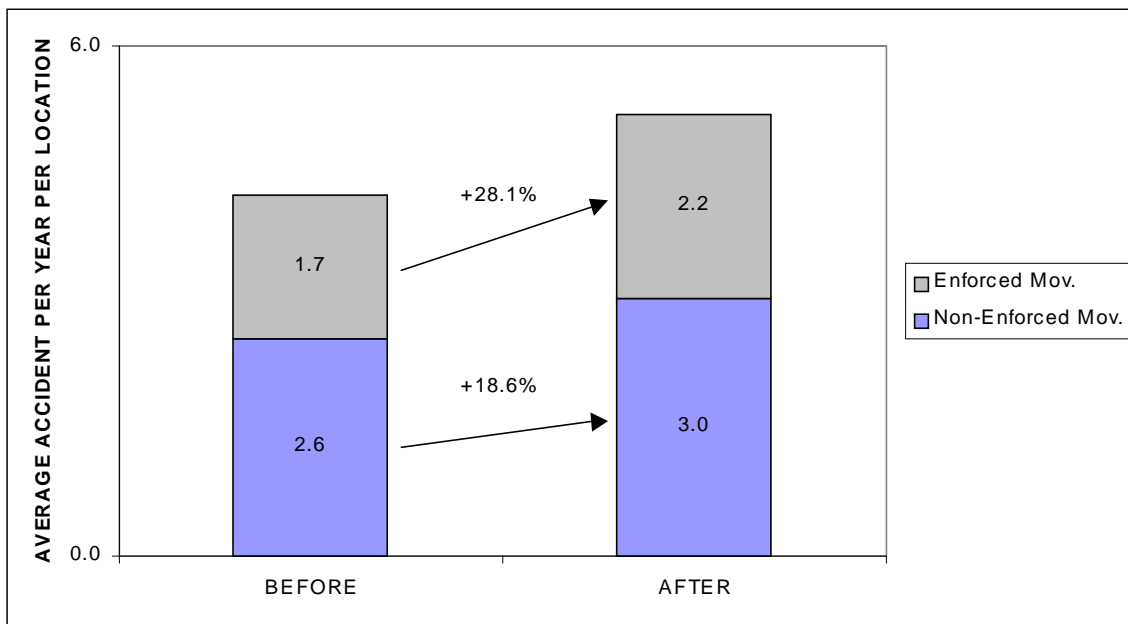


Figure 2-13
REAR END ACCIDENT RATES FOR ENFORCED AND NON-ENFORCED MOVEMENTS AT INTERSECTIONS WHERE LEFT TURN MOVEMENTS ENFORCED

2.4.5 Longer Run Rear End Accident Rate Changes

It may be reasonable to assume that motorists will adapt to the new driving environment over time. After a number of months of photo enforcement operations, motorists may pay more attention to vehicles stopping more often in front of them at signalized intersections. As a result, it might be expected that the observed increases in the rate of RE accidents after photo enforcement will decline over time and, eventually, may approach to the RE accident rate observed before photo enforcement was commenced. To assess this possibility, the RE accident rates after photo enforcement have been computed separately for the photo-enforced intersections according to the length of time that the intersections have been enforced.

Figure 2-14 shows the variation in the overall RE accident rate for the photo-enforced intersections over time. The RE accident rate during the first year of photo enforcement increased from 3.3 accidents per year, before photo enforcement, to 5.2 accidents per year. During the second and third enforcement years, the rates fluctuated but they were not greater than that of the first year. During the fourth enforcement year, the RE accident rate dropped to near the rate observed before photo enforcement.

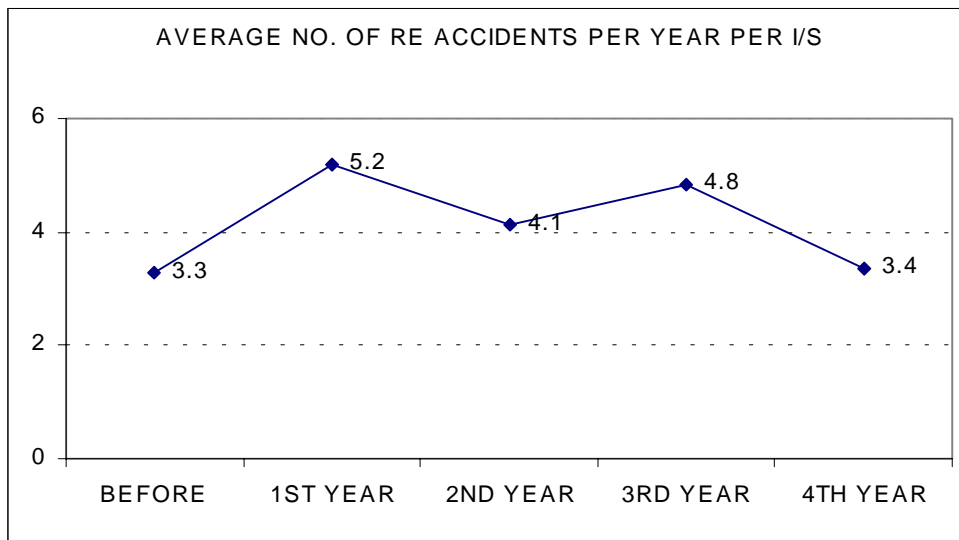


Figure 2-14
LONGER RUN REAR END ACCIDENT RATES CHANGES

Due to data limitations, the RE accident rates could not be computed for more years. However, Figure 2-13 indicates the decreasing trend in the RE accident rates at the photo-enforced intersections as the length of the photo enforcement period increases. It remains to be determined if the downward trend is maintained for longer time periods.

2.5 COMPARISON WITH OTHER PHOTO ENFORCEMENT PROGRAMS

Table 2-3 provides a summary of the changes in red light running violations, accidents attributable to red light running violations, and rear end collisions. Care must be taken in using the data presented in this table as the data sources and methods used for analysis are varied and, in some instances, taken from reports by third parties.

Table 2-3
REDUCTIONS IN RED LIGHT RUNNING VIOLATIONS AND COLLISIONS
FOR SELECTED PHTO ENFORCEMENT PROGRAMS

Jurisdiction	State	Number of Intersections	Percent Change In Red Light Running Violations	Percent Change In Rear End Collisions	Percent Change In RLR-Related Collisions
Charlotte	North Carolina	27	(20)	N/A	(24)
Fairfax	Virginia	9	(44)	N/A	N/A
Howard County	Maryland	2	(42)	(30)	(21-44)
Los Angeles	California	1	(34)	N/A	N/A
New York City	New York	30	(34)	N/A	(60-70)
Oxnard	California	15	(42)	N/A	(29-32)
Polk County	Florida	N/A	N/A	N/A	(7)
San Francisco	California	5	(42)	N/A	N/A
San Diego	California	19	(20-24)	+37	(30)
Scottsdale	Arizona	N/A	(62)	N/A	N/A
Washington	DC	N/A	(56)	N/A	N/A
Wilmington	North Carolina	N/A	(40-60)	+8	(26)

2.6 FINDINGS AND RECOMMENDATIONS

- The City's photo enforcement program has resulted in a significant reduction in the number of red light running violations at the photo-enforced intersections. The measured reduction in red light running violations at intersections where cameras have been operational for six months varies from 20 percent to nearly 24 percent. Furthermore, the measured reductions in red light running violations have remained about the same as the cameras have been operated for longer periods of time.

The reduction in red light running violations is generally not as high as reported for other photo enforcement programs.

Generally, reductions in the number of violations are about the same for photo-enforced intersections where through red light running violations are being monitored and locations where left turn movements are being enforced.

- The City's photo enforcement program has resulted in significant reductions in the number of collisions attributable to red light running at the photo-enforced intersections, especially on the photo-enforced approaches where an overall reduction of 46 percent has been measured. This is an important finding and indicates that the program, on the whole, has been effective in reducing the number of accidents resulting from red light running at signalized intersections.

For intersections where through red light running violations are being monitored, the accident rate for accidents attributable to red light running has declined by 44 percent. For the photo-enforced approaches only at these intersections, the reduction in collisions is an impressive 60 percent.

San Diego Photo Enforcement System Review

For intersections where left turn red light running violations are being monitored, the accident rate for accidents attributable to red light running has declined by 20 percent. For the photo-enforced approaches only at these intersections, the number of collisions due to red light running dropped by only 12 percent, less than for all intersection approaches.

Overall, the analysis of the accident data indicates that the photo enforcement program has generated significant reductions in the number of accidents attributable to red light running. The accident rate reductions have been highest for intersections where through traffic movements are being monitored.

- The number of accidents attributable to red light running was found to be remarkably low at three photo-enforced intersections: NB Bernardo Drive to WB Rancho Bernardo Drive (1414); SB Harbor Drive to EB Grape Street (1533); and SB Mission Boulevard at Garnet Avenue (1542).

One of these locations, at North Harbor Drive and Grape Street, has accounted for nearly one-quarter of the recorded violations and citations issued under the City's photo enforcement program. This location has not experienced a high number of accidents attributable to red light running either before or after photo enforcement. Generally, the locations selected for photo enforcement should be intersections where there are higher numbers of collisions resulting from motorists running red lights.

- Overall, the accident rate at the photo-enforced intersections increased by three percent after the installation of the photo enforcement cameras. This finding is not consistent with the program's overall objective of improving traffic safety for the City's motorists.

The increase in the overall accident rate has resulted directly from an increase in the number of rear end collisions, an increase that has more than offset the reduced number of collisions resulting from motorists running red lights. After photo enforcement, the average rate of rear end accidents increased by 37 percent after photo enforcement.

Rear end accidents increased by the largest amount, about 62 percent, for enforced through movements. Rear end accidents increased by the least amount, about 19 percent, for non-enforced left turn movements.

While the rate of rear end collisions increased for the photo-enforced intersections, it was noted that the rate of rear end collisions dropped over time and, for those intersections where photo enforcement cameras have been in place for about three years, returned to the before enforcement level. This finding, based on limited data, suggests that the increased rate of rear end collisions will not be sustained over time. Additional data is needed to confirm that the increased rate of rear end collisions will not be sustained over time.